Development of 3D Bioprinting Techniques using Human Embryonic Stem Cells Derived Cardiomyocytes for Cardiac Tissue Engineering

Grant Award Details

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Grant Type:	Tools and Technologies III
Grant Number:	RT3-07899
Project Objective:	To improve viability and cardiac functionality of stem-cell based treatments for congestive heart failure. The awardee will develop and optimize a pre-vascularized cardiac tissue construct containing hyaluronic acid (HA)-based biomaterials and hESC-derived cardiomyocytes using 3D bioprinting techniques developed in his laboratory. The construct will be evaluated in vivo for function in Hu-mice and rat myocardial infarction models.

Investigator:

Name:	Shaochen Chen
Institution:	University of California, San Diego
Type:	PI

Disease Focus:	Heart Disease
Human Stem Cell Use:	Embryonic Stem Cell, iPS Cell
Cell Line Generation:	Embryonic Stem Cell
Award Value:	$1,368,517
Status:	Active

Progress Reports

Reporting Period:	Year 1
View Report	

Grant Application Details

Application Title:	Development of 3D Bioprinting Techniques using Human Embryonic Stem Cells Derived Cardiomyocytes for Cardiac Tissue Engineering

Public Abstract: Heart, stroke and other cardiovascular diseases are responsible for ~17 million deaths per year globally and this number is predicted to reach 23.3 million by 2030. Cardiovascular diseases impose a staggering annual cost of $300 billion on the U.S. health care system. Heart transplantation is the ultimate solution to end-stage heart failure. However, a major limitation in treating cardiac injury is the limited availability of donors; as a result, only a small fraction of patients will benefit from heart transplantation. Tissue engineering holds a great promise to create functional tissue constructs that can reestablish the structure and function of injured tissue with exciting success stories. However, many challenges regarding their development still remain. It is the goal of this project to develop a novel 3D bioprinting technology to fabricate cardiac tissues made from cell-laden hydrogels with engineered microvasculature. By integrating the advanced 3D bioprinting with stem cell technology, functional cardiac tissues will be created with biomimetic 3D microarchitecture and functional vasculature. This novel 3D-printed cardiac tissue will heal the damaged heart and improve its function to pave the way for a superior treatment option for the millions of cardiac patients in the U.S.

Statement of Benefit to California: Heart disease and other cardiovascular diseases are the #1 killer in California and remain a leading cause of disability and death. A major limitation in treating cardiac injury is the failure of current therapies to induce myocardium regeneration. Due to the limited availability of donors, only a fraction of individuals who could benefit from heart transplantations actually receive them. One possible avenue for remedying this situation is to artificially engineer cardiac tissues. Tissue engineering techniques have been successfully applied to engineer many types of tissue; however, many challenges regarding their development still remain. This proposal aims to make an advance in tissue engineering by developing a novel 3D bioprinting technology to fabricate tissues made from cell-laden hydrogels with engineered microvasculature. The completion of this work will be a paradigm shift and a landmark achievement in efforts towards clinical treatments of vascularized cardiac tissue using stem cells. This advanced technology can also have a significant economical impact as heart diseases impose a staggering annual cost of $300 billion on the U.S. health care system. In addition, the development of the 3D bioprinting technology and advanced biomaterials will keep California and the U.S. as a whole in the leading position in this emerging field.

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